Part 1 General

1.1 SUBMITTALS

.1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.

.2 Shop drawings to show:

- .1 Mounting arrangements.
- .2 Operating and maintenance clearances.

.3 Shop drawings and product data accompanied by:

- .1 Detailed drawings of bases, supports, and anchor bolts.
- .2 Acoustical sound power data, where applicable.
- .3 Points of operation on performance curves.
- .4 Manufacturer to certify current model production.
- .5 Certification of compliance to applicable codes.

.4 In addition to transmittal letter referred to in Section 01 33 00 - Submittal Procedures: use MCAC "Shop Drawing Submittal Title Sheet". Identify section and paragraph number.

.5 Closeout Submittals:

- .1 Provide operation and maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
- .2 Operation and maintenance manual approved by, and final copies deposited with, Departmental Representative before final inspection.
- .3 Operation data to include:
  - .1 Control schematics for systems including environmental controls.
  - .2 Description of systems and their controls.
  - .3 Description of operation of systems at various loads together with reset schedules and seasonal variances.
  - .4 Operation instruction for systems and component.
  - .5 Description of actions to be taken in event of equipment failure.
  - .6 Valves schedule and flow diagram.
  - .7 Colour coding chart.
- .4 Maintenance data to include:
  - .1 Servicing, maintenance, operation and trouble-shooting instructions for each item of equipment.
  - .2 Data to include schedules of tasks, frequency, tools required and task time.
- .5 Performance data to include:
  - .1 Equipment manufacturer's performance datasheets with point of operation as left after commissioning is complete.
  - .2 Equipment performance verification test results.
  - .3 Special performance data as specified.
  - .4 Testing, adjusting and balancing reports as specified in Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC.

.6 Approvals:

.1 Submit two (2) copies of draft Operation and Maintenance Manual to Departmental Representative for approval. Submission of individual data will not be accepted unless directed by Departmental Representative.

.2 Make changes as required and re-submit as directed by Departmental Representative.

.7 Additional data:

.1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.

.8 Site records:

.1 Departmental Representative will provide one (1) set of reproducible mechanical drawings. Provide sets of white prints as required for each phase of work. Mark changes as work progresses and as changes occur. Include changes to existing mechanical systems, control systems and low voltage control wiring.

.2 Transfer information weekly to reproducibles, revising reproducibles to show work as actually installed.

.3 Use different colour waterproof ink for each service.

.4 Make available for reference purposes and inspection.

.9 As-built drawings:

.1 Prior to start of Testing, Adjusting, and Balancing for HVAC, finalize production of as-built drawings.

.2 Identify each drawing in lower right hand corner in letters at least 12 mm high as follows: - "AS BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) and (Date).

.3 Submit to Departmental Representative for approval and make corrections as directed.

.4 Perform testing, adjusting, and balancing for HVAC using as-built drawings.

.5 Submit completed reproducible as-built drawings with Operating and Maintenance Manuals.

.10 Submit copies of as-built drawings for inclusion in final TAB report.

1.2 MAINTENANCE

.1 Furnish spare parts in accordance with Section 01 78 00 - Closeout Submittals as follows:

.1 One set of packing for each pump.

.2 One casing joint gasket for each size pump.

.3 One glass for each gauge glass.

.2 Provide one set of special tools required to service equipment as recommended by manufacturers and in accordance with Section 01 78 00 - Closeout Submittals.

.3 Furnish one commercial quality grease gun, grease and adapters to suit different types of grease and grease fittings.

Part 2 Products

2.1 N/A

Part 3 Execution

3.1 CLEANING

.1 Clean interior and exterior of all systems.

3.2 DEMONSTRATION

.1 Departmental Representative may use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.

.2 Trial usage to apply to following equipment and systems:

.1 City water booster pump system.

.3 Supply tools, equipment, and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, trouble-shooting, and servicing of all systems and equipment during regular work hours and prior to acceptance.

.4 Use operation and maintenance manual, as-built drawings, and audio visual aids as part of instruction materials.

.5 Instruction duration time requirements as specified in appropriate sections.

.6 Departmental Representative may record these demonstrations on videotape for future reference.

3.3 PROTECTION

.1 Protect equipment and systems openings from dirt, dust, and other foreign materials with materials appropriate to system.

END OF SECTION

Part 1 GENERAL

1.1 SECTION INCLUDES

.1 Variable Speed Pumping Package

.2 Pump Control Panel

.3 Variable Frequency Drive

.4 Sensor Transmitters

.5 Sequence of Operation

1.2 REFERENCES

.1 AWWA - American Water Works Association

.2 ANSI - American National Standards Institute

.3 ASTM - American Standards for Testing Materials

.4 HI - Hydraulic Institute

.5 ASME - American Society of Mechanical Engineers

.6 UL - Underwriters Laboratories

.7 ISO - International Standards Organization

.8 NEMA - National Electrical Manufacturers Association

.9 ETL - Electrical Testing Laboratories

.10 CSA - Canadian Standards Association

.11 NEC - National Electrical Code

.12 IEC - International Electrotechnical Commission

.13 NSF – NSF International

.14 ISO – International Organization for Standardization

.15 ASHRAE – American Society of Heating, Refrigerating and Air-Conditioning Engineers

1.3 SUBMITTALS

SUBMITTALS SHALL INCLUDE THE FOLLOWING:

.1 System summary sheet.

.2 Sequence of operation.

.3 Shop drawing indicating dimensions, required clearances and location and size of each field connection and anchoring detail.

.4 Power and control wiring diagrams.

.5 System profile analysis including variable speed pump curves and system curve. The analysis shall also include pump & motor efficiencies, staging points, job specific load profile, horsepower and kilowatt/hour consumption.

.6 Pump data sheets.

.7 Submittals must be specific to this project. Generic submittals will not be accepted.

.8 Each supplier shall list any exceptions to the specification. If no departures from the specification are identified, the supplier shall be bound by the specification.

1.4 QUALITY ASSURANCE

.1 The pumping package shall be assembled by the pump manufacturer. An assembler of pumping systems not actively engaged in the design and construction of centrifugal pumps shall not be considered a pump manufacturer. The manufacturer shall assume "Unit Responsibility" for the complete pumping package. Unit responsibility shall be defined as responsibility for interface and successful operation of all system components supplied by the pumping system manufacturer.

.2 The pumping system shall be factory tested to the job-specific condition points prior to shipment. A check test procedure shall be conducted with motors connected to VFD output / motor starters (VFD output if VS) and it shall test all inputs, outputs, and program execution specific to this application, including presetting of all job specific program parameters.

.3 The pumping package shall be certified by an approved independent testing and certification organization as being compliant with the requirements of NSF/ANSI 61 for potable drinking water and NSF-61 Annex G for low lead content.

.4 Manufacturer shall be listed by UL as a manufacturer of packaged pumping systems under UL/cUL category QCZJ.

.7 Manufacturer shall be listed by UL as a manufacturer of control panels under UL 508A.

.5 The manufacturer’s production facility shall be certified by an approved independent testing and certification organization as being compliant with the requirements of NSF/ANSI 61 and NSF-61 Annex G. The manufacturing facility shall be subjected to periodic inspections and audits.

Part 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

.1 All selection submissions for each pump set manufacturer are subject to compliance with these specifications, and must be pre-approved by and to the satisfaction of the Departmental Representative prior to tender.

2.2 MANUFACTURED UNITS

.1 Furnish and install, as shown on the plans, a VSD-driven pump set. Each individual pump (as part of overall pumping set) shall be capable of delivering a continuous flowrate of 20 litres per second at a pressure differential of 450 kPa.

Suction and discharge headers shall be 300 mm in diameter and constructed of 304 series stainless steel.

.2 Manufacturer shall be listed by Underwriters Laboratories as a manufacturer of packaged pumping systems.

.3 The entire pumping package shall be NSF/ANSI/NSF-61 certified for potable drinking water and NSF-61 Annex G for a wetted area, weighted average lead content ≤0.25%.

.4 The system shall meet or exceed the intent of ASHRAE 90.1-2010 and include a friction loss compensation algorithm such that a remotely mounted sensor is not required.

.5 The control system shall include, as a minimum, the programmable logic station controller, variable frequency drives, a manifold mounted 4-20mA pressure transducer, and any additional equipment as specified or as required to properly executing the sequence of operation.

.6 System shall require only suction, discharge and drain connections and single point power connection from a service entrance disconnect.

.7 All components shall be mounted and shipped as a single unit.

.8 The discharge of each pump shall be fitted with a check valve appropriate for station operation. Each pump and discharge valve assembly shall also be equipped with isolation valves so that the pump can be serviced while system is still filled.

.9 Pressure gauges shall be installed on the suction and discharge headers.

.10 Piping shall be sized so that water velocity shall not exceed three (3) metres per second in either the valves or manifolds.

.11 Pumps shall be protected from thermal accumulation via individual thermal purge assembly relief mechanisms.

.12 The system shall not be comprised of proprietary components (eg. motors, drives, etc.) that limit the user to a single source for replacement components.

2.3 COMPONENTS

.1 PUMP LOGIC CONTROLLER

.1 Enclosure shall be NEMA 4 with a NEMA 4 operator interface. The pump logic controller shall be listed by and bear the label of Underwriter's Laboratory, Inc. (UL/cUL). The controller program shall be specifically designed by the pump manufacturer for packaged pressure booster applications.

.2 The control panel with controls shall be built in accordance with NEC, and shall comply with UL standards. Pump station manufacturer shall be authorized under UL508A to manufacture its own control panels. All equipment and wiring shall be mounted within the enclosure and each device shall be labeled with proper identification. All adjustments and maintenance shall be accessible from the front

of the control enclosure. A complete wiring circuit diagram and legend with terminals, components, and wiring completely identified shall be provided. Main disconnect shall be interlocked with door and shall have a through door operator and be sized as shown in the technical data sheet. The control enclosure shall be constructed of 14-gauge steel and the back plate assembly shall be constructed of 14-gauge steel.

.3 One (1) or more industrial grade programmable logic controllers shall handle all control logic. The PLC(s) shall provide demand-controlled sequential pump start-up, shutdown and safety features through pressure sensing, flow sensing and voltage sensing devices. An LED visual status light is provided for each I/O point to indicate on/off status. Industrial grade programmable logic controllers shall handle all logic for system control, timing, and control of VFD speed. All PLCs shall have a built-in clock calendar and shall communicate via the internal 100-megabit Ethernet network. PLC shall possess a minimum of two (2) megabytes of total memory.

.4 The pump logic controller shall be microcomputer-based and hold its software in a non-volatile flash memory. On-line field-modified data entries, such as set point, alternation, serial communication, and sensor setup, as a minimum, shall be stored in non-volatile memory storage to prevent accidental loss of data due to voltage surge or spike. In the event of a complete power outage, all control parameters shall remain in tact with the controller capable of resuming operation immediately upon restoration of power. All factory-preset and saved data values will be available for recall by the operator. Software changes/ updates shall be possible through Ethernet connection to a personal service technician computer.

.5 The controller must not require connection to a battery to maintain power settings on controller during periods of loss of supply power.

.6 The controller shall provide internal galvanic isolation to all digital and analog inputs as well as all fieldbus connections.

.7 All pump station shutdowns shall be of the controlled type that sequentially retires pumps at user selectable intervals to reduce water hammer within the system. Phase fault shutdowns shall have accelerated rate to minimize motor damage.

.8 Minimum pump-run time shall be user adjustable.

.9 Pump Alternation:

.1 The controller shall offer both manual and automatic pump alternation. An alternation sequence that permits severe pressure fluctuations or requires a no flow situation prior to alternation shall not be acceptable.

.2 The controller shall be capable of alternating the pumps per a user-selectable day and time to ensure alternation occurs at a time of low demand.

.3 The controller shall, by default, alternate to the pump with the least run hours, thereby ensuring equal operation of all pumps, and will not alternate if the lead pump has less run hours than any lags.

.10 The pump logic controller shall be capable of accepting individual analog inputs from multiple zone sensor/transmitters as standard while being expandable to meet requirements as indicated on the plans. The controller will control to the zone with the current pressure furthest away from its set point and shall indicate on the main screen which zone is the controlling variable.

.11 In the event of drive or controller failure, the station shall have the option of panel integrated Hand- Off-Auto switches with a speed potentiometer and automatic bypass of the drives.

.12 The station shall have a short circuit current rating (SCCR) of at least 5000A.

.13 Analog input resolution shall be 12-bit minimum and the controller shall scan each analog input a minimum of once every 50-milliseconds. Use of a multiplexer for multiple sensor inputs is not acceptable. All sensor/transmitter inputs shall be individually wired to the pump logic controller for continuous scan and comparison function. All analog inputs shall be provided with current limit circuitry to provide short circuit protection and safeguard against incorrect wiring of sensors.

.14 The variable speed pump logic controller shall function to a proven program that safeguards the pumps/system against damaging hydraulic conditions including:

.1 Motor Overload.

.2 Pump Flow Surges.

.3 Hunting.

.4 End of Curve Protection: The pump logic controller, through a factory pre-programmed algorithm, shall be capable of protecting the pumps from damage and premature failure.

.15 The pump logic controller and operator interface shall be capable of controlling from 1-8 pumps with up to 15 sequencing combinations for different sized pumps including but not limited to jockey, pressure maintenance, and high flow pumps.

.1 Operator may select whether jockey pump continues to operate when larger pumps engage.

.16 The number of standby pumps shall be user-selectable and the controller shall alternate standby pumps into the control sequence to ensure equal run time over all pumps. Seventeen (17) distinct set point pressures are available (normal, lockouts 1 through 14 and two (2) alternate, SCAD or digital input driven). The high-pressure set point can be tied into a computerized or directly-linked to high elevation satellites. When high-elevation satellites are operating, control software will automatically and gradually elevate the pressure to the new desired set point. When finished, the high set point will be lowered back to normal. The high elevation set point will only be used if called out on the technical data sheet.

.17 An energy saving set point scheduling feature shall be provided allowing for an alternate set point for certain hours of the weekdays or weekend.

.18 The controller shall include a system pipe fill mode will be included to automatically and gradually refill and pressurize the system, preventing surges, over-shoot and water hammer on commissioning or restarting due to power-loss. All Line Fill and Ramp Up parameters are adjustable. The acceleration control of the VFD is NOT an acceptable means of controlling pressure ramp up:

.1 Upon detecting the extreme low pressure condition at start-up, the system shall monitor system pressure and flow (measured or calculated) to prevent the formation of hydraulic waves in the system, gradually and steadily increasing system output to allow air to be purged by air relief valves in the system.

.2 Ramp Up: Once pressure is sufficient, the mode will switch to ramp-up mode, increasing pressure over time (i.e., 1 PSI every 4 seconds) without overshooting set point pressure. This ramp up time is fully adjustable by

the operator. This control feature is based on an increase in pressure over a pre-defined time period.

.19 To maximize energy efficiency the controller shall be capable of using logic to simulate the operation of a sensor located at the critical fixtures such that the friction loss associated with varying flow through the system is compensated for by corresponding set point adjustments. This feature shall not require the use of a flow meter but will display the estimated flow rate on the main screen of the HMI.

.20 Generator Power Mode: In the event of a grid power outage, the controller shall be capable of receiving a digital input that will limit the station's maximum power consumption to a set value. Pumps will continue to alternate as scheduled or as required should an active pump experience a fault.

.1 If a flow meter is installed in the system and fails, the controller shall automatically switch to flow estimation.

.21 Human Machine Device (HMI). The pump station shall include a NEMA 4 touch screen display mounted on the control panel door. This device shall allow the operator to view and selectively modify all registers in the PLC. The unit shall store its messages in non-volatile memory.

.1 The human machine interface device shall incorporate multi-level password protection for protecting data integrity.

.2 The HMI shall be self-prompting. All messages shall be displayed in plain English. The following features shall be provided: Multi-fault memory and recall on-screen help functions.

.3 The display shall employ user-friendly dynamic pump images to clearly indicate pump status. Text-only displays shall not be acceptable.

.4 The device shall include Hand-Off-Auto functionality without the need for separate switches.

.5 The device shall allow display and modification of all timers, set points, lockout times, etc. and shall display at a minimum the following values from the main screen:

.1 Pump On/Off Status.

.2 Pump % Speed.

.3 VFD Frequency (Hz).

.4 Power consumption (kW).

.5 Flow Rate (Flow meter required).

.6 Estimated Flow Rate (Flow meter not required).

.7 Pump run time.

.8 Individual Pump Alarm Conditions.

.9 Peripheral Component Alarm Conditions.

.10 Discharge Pressure (kPa).

.11 Suction Pressure (kPa).

.12 System Set Point (kPa or m).

.13 Troubleshooting Diagnostics.

.14 User-adjustable parameters such as alternation, PID, set points, etc.

.6 The device shall communicate with the PLC through the internal Ethernet network.

.7 The device's program shall be updateable via flash drive.

.22 The controller shall possess the following Alarms as a minimum, and may employ addition job specific alarms, safeties, and shutdown faults as needed. All alarms will be indicated by a flashing red notification on the screen and one touch will provide details along with procedures for correction. Alarms will be displayed in plain English - not fault codes. Three unsuccessful restarts in 60-minute period will give hard shutdown.

.1 Low discharge pressure

.2 Individual motor overload/phase loss (indicates which individual motor was shut down) Manual reset only. Automatic reset is not acceptable.

.23 Warnings: The controller shall permit warnings to be set for select alarms and will flash yellow notifications on the screen.

.24 A data-logging feature shall be provided as a function of the HMI. The Alarm log shall include the last ninety (90) days of alarms and warnings with date/time stamp. The Pump data log shall display individual pump run timers and pump cycle counters. A Signal log shall be provided to display the maximum and minimum values with date/time stamps for each process variable.

.25 The HMI shall, at one button press, display graphical trends of logged and calculated values. The display shall be user-selectable between historical data trend and current real-time trend. The operator shall be able to select parameters and assign to the y-axis for the previous thirty (30) days, six (6) weeks, five (5) years, or between a specific date/time range. Selectable parameters shall include at a minimum the following:

.1 Discharge Pressure

.2 Set Point

.3 Energy consumption

.4 Flow rate

.5 Value from analog input (flow, pressure, level etc)

.26 The HMI shall display easily readable tables of totalized values for energy and flow consumption across the previous day, weeks (5), months (12), years (5).

.1 The daily energy and flow-totalized values shall be available for download on the controller in CSV file format by a PC on the controller's network.

.27 The pump controller shall be capable of communicating with the Building Automation System (BAS) by both hard-wired and serial communications. The controller shall include at minimum two (2) 4-20mA analog output signals and four (4)digital input/outputs that can be programmed to any of the below features (additional I/O cards may be selected to allow for more hardwired communication points as required.):

.1 Remote system start/stop (dry contact supplied by BAS)

.2 System on/off status

.3 Hard Fault

.4 Individual Pump Alarm

.5 Low Suction Pressure Alarm

.6 Low Water Level

.7 Analog System Fault

.8 High Pressure Alarm

.9 Low Temperature Alarm
.10 High Temperature Alarm
.11 VFD in Bypass (read only)
.12 Pump Status
.13 Lockout Status
.14 Auxiliary Set Point Inputs
.15 Current Set Point (4-20mA)
.16 Current System Pressure (4-20mA)
.17 Suction Pressure (4-20mA)
.18 Current Level (4-20mA)
.19 Flow (4-20mA flow sensor required)
.20 VFD speed (4-20mA)

.28 The following communication features shall be provided to the Building Automation System via an RJ45 port utilizing Modicon Modbus, BACnet MS/TP or BACnet IP protocol:

.1 All sensor process variables
.2 Individual zone setpoints
.3 Individual pump failure
.4 Individual pump on/off status
.5 Individual VFD on/off status
.6 VFD speed
.7 Individual VFD Failure
.8 Individual sensor failure
.9 Alarms
.10 Warnings

.29 The controller shall be capable of being remotely accessed via web interface using an integrated Ethernet connection. The web interface will simulate the controller interface and will provide virtually the same functionality as being in front of the station. To prevent damage to the pumps or system the web interface will not permit clearing of hard faults.

.2 VARIABLE FREQUENCY DRIVE

.1 Description:

.1 This specification covers complete variable frequency drives (VFDs) designated on the drawing schedules to be variable speed. All standard and optional features shall be included within the VFD panel.

.2 The VFD shall be rated NEMA 12. Manufacturer shall supply a copy of the UL plenum evaluation upon request.

.3 The VFD shall be tested to UL 508C. The appropriate UL label shall be applied. When the VFDs are to be located in Canada, C-UL certifications shall apply. VFD shall be manufactured in ISO 9001, 2000 certified facilities.

.4 The VFD shall be UL listed for a short circuit current rating of 100 kA and labeled with this rating.

.5 The VFD manufacturer shall supply the VFD and all necessary controls as herein specified.

.2 Components:

.1 The VFD shall convert incoming fixed frequency three-phase AC power into an adjustable frequency and voltage for controlling the speed of three-phase AC motors. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for the driven load and to eliminate the need for motor de-rating.

.2 When properly sized, the VFD shall allow the motor to produce full rated power at rated motor voltage, current, and speed without using the motor's service factor. VFDs utilizing sine weighted/coded modulation (with or without 3rd harmonic injection) must provide data verifying that the motors will not draw more than full load current during full load and full speed operation.

.3 The VFD shall include an input full-wave bridge rectifier and maintain a fundamental (displacement) power factor near unity regardless of speed or load.

.4 The VFD shall have a dual 5% impedance DC link reactor on the positive and negative rails of the DC bus to minimize power line harmonics and protect the VFD from power line transients. The chokes shall be non-saturating. Swinging chokes that do not provide full harmonic filtering throughout the entire load range are not acceptable. VFDs with saturating (non-linear) DC link reactors shall require an additional 3% AC line reactor to provide acceptable harmonic performance at full load, where harmonic performance is most critical.

.5 VFD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 120% of rated torque for up to 0.5 second while starting.

.6 A programmable automatic energy optimization selection feature shall be provided standard in the VFD. This feature shall automatically and continuously monitor the motor’s speed and load to adjust the applied voltage to maximize energy savings.

.7 Output power circuit switching shall be able to be accomplished without interlocks or damage to the VFD.

.8 An automatic motor adaptation algorithm shall measure motor stator resistance and reactance to optimize performance and efficiency. It shall not be necessary to run the motor or de-couple the motor from the load to perform the test.

.9 Galvanic isolation shall be provided between the VFD’s power circuitry and control circuitry to ensure operator safety and to protect connected electronic control equipment from damage caused by voltage spikes, current surges, and ground loop currents. VFDs not including either galvanic or optical isolation on both analog I/O and discrete digital I/O shall include additional isolation modules.

.10 VFD shall minimize the audible motor noise through the use of an adjustable carrier frequency. The carrier frequency shall be automatically adjusted to optimize motor and VFD operation while reducing motor noise. VFDs with fixed carrier frequency are not acceptable.

.3 Protective Features:

.1 A minimum of Class 20 I2t electronic motor overload protection for single motor applications shall be provided. Overload protection shall automatically compensate for changes in motor speed.

.2 Protection against input transients, loss of AC line phase, output short circuit, output ground fault, over voltage, under voltage, VFD over temperature and motor over temperature. The VFD shall display all faults in plain language. Codes are not acceptable.

.3 Protect VFD from input phase loss. The VFD should be able to protect itself from damage and indicate the phase loss condition. During an input phase loss condition, the VFD shall be able to be programmed to either trip off while displaying an alarm, issue a warning while running at reduced output capacity, or issue a warning while running at full commanded speed. This function is independent of which input power phase is lost.

.4 Protect from under voltage. The VFD shall provide full rated output with an input voltage as low as 90% of the nominal. The VFD will continue to operate with reduced output, without faulting, with an input voltage as low as 70% of the nominal voltage.

.5 Protect from over voltage. The VFD shall continue to operate without faulting with a momentary input voltage as high as 130% of the nominal voltage.

.6 The VFD shall incorporate a programmable motor preheat feature to keep the motor warm and prevent condensation build up in the motor when it is stopped in a damp environment by providing the motor stator with a controlled level of current.

.7 VFD shall include a “signal loss detection” algorithm with adjustable time delay to sense the loss of an analog input signal. It shall also include a programmable time delay to eliminate nuisance signal loss indications. The functions after detection shall be programmable.

.8 VFD shall function normally when the keypad is removed while the VFD is running. No warnings or alarms shall be issued as a result of removing the keypad.

.9 VFD shall catch a rotating motor operating forward or reverse up to full speed without VFD fault or component damage.

.10 Selectable over-voltage control shall be provided to protect the drive from power regenerated by the motor while maintaining control of the driven load.

.11 VFD shall include current sensors on all three output phases to accurately measure motor current, protect the VFD from output short circuits, output ground faults, and act as a motor overload. If an output phase loss is detected, the VFD will trip off and identify which of the output phases is low or lost.

.12 If the temperature of the VFD’s heat sink rises to 80°C, the VFD shall automatically reduce its carrier frequency to reduce the heat sink temperature. It shall also be possible to program the VFD so that it reduces its output current limit value if the VFD’s temperature becomes too high.

.13 In order to ensure operation during periods of overload, it must be possible to program the VFD to automatically reduce its output current to

a programmed value during periods of excessive load. This allows the VFD to continue to run the load without tripping.

.14 The VFD shall have temperature controlled cooling fan(s) for quiet operation, minimized losses, and increased fan life. At low loads or low ambient temperatures, the fan(s) may be off even when the VFD is running.

.15 The VFD shall store in memory the last ten (10) alarms. A description of the alarm, and the date and time of the alarm shall be recorded.

.16 When used with a pumping system, the VFD shall be able to detect no-flow situations, dry pump conditions, and operation off the end of the pump curve. It shall be programmable to take appropriate protective action when one of the above situations is detected.

.4 Interior Features:

.1 Hand, Off and Auto keys shall be provided to start and stop the VFD and determine the source of the speed reference. It shall be possible to either disable these keys or password protect them from undesired operation.

.2 There shall be an “Info” key on the keypad. The Info key shall include “on-line” context sensitive assistance for programming and troubleshooting.

.3 The VFD shall be programmable to provide a digital output signal to indicate whether the VFD is in Hand or Auto mode. This is to alert the Building Automation System whether the VFD is being controlled locally or by the Building Automation System.

.4 Password protected keypad with alphanumeric, graphical, backlit display can be remotely mounted. Two levels of password protection shall be provided to guard against unauthorized parameter changes.

.5 All VFDs shall have the same customer interface. The keypad and display shall be identical and interchangeable for all sizes of VFDs.

.6 To set up multiple VFDs, it shall be possible to upload all setup parameters to the VFD’s keypad, place that keypad on all other VFDs in turn and download the setup parameters to each VFD. To facilitate setting up VFDs of various sizes, it shall be possible to download from the keypad only size independent parameters. Keypad shall provide visual indication of copy status.

.7 Display shall be programmable to communicate in English and French.

.8 A red FAULT light, a yellow WARNING light and a green POWER-ON light shall be provided. These indications shall be visible both on the keypad and on the VFD when the keypad is removed.

.9 A quick setup menu with factory preset typical HVAC parameters shall be provided on the VFD. The VFD shall also have individual Fan, Pump, and Compressor menus specifically designed to facilitate start-up of these applications.

.10 The VFD’s PID controller shall be able to actively adjust its setpoint based on flow. This allows the VFD to compensate for a pressure feedback sensor, which is located near the output of the pump rather than out in the controlled system.

.11 Floating point control interface shall be provided to increase/decrease speed in response to contact closures.

.12 Five simultaneous meter displays shall be available. They shall include at a minimum, frequency, motor current, motor voltage, VFD output power, VFD output energy, VFD temperature in degrees, actual process variable and set point among others.

.13 Programmable Sleep Mode shall be able to stop the VFD. When its output frequency drops below set “sleep” level for a specified time, when an external contact commands that the VFD go into Sleep Mode, or when the VFD detects a no-flow situation, the VFD may be programmed to stop. When the VFD’s speed is being controlled by its PID controller, it shall be possible to program a “wake-up” feedback value that will cause the VFD to start. To avoid excessive starting and stopping of the driven equipment, it shall be possible to program a minimum run time before sleep mode can be initiated and a minimum sleep time for the VFD.

.14 A run permissive circuit shall be provided to accept a “system ready” signal to ensure that the VFD does not start until dampers or other auxiliary equipment are in the proper state for VFD operation. The run permissive circuit shall also be capable of initiating an output “run request” signal to indicate to the external equipment that the VFD has received a request to run.

.15 VFD shall be programmable to display feedback signals in appropriate units, such as inches of water column (in-wg), pressure per square inch (psi) or temperature (°F).

.16 VFD shall be programmable to sense the loss of load. The VFD shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communications bus. To ensure against nuisance indications, this feature must be based on motor torque, not current, and must include a proof timer to keep brief periods of no load from falsely triggering this indication.

.5 Standard Inputs and Outputs:

.1 Four dedicated, programmable digital inputs shall be provided for interfacing with the systems control and safety interlock circuitry.

.2 Two terminals shall be programmable to act either as digital outputs or additional digital inputs.

.3 Two programmable relay outputs, Form C 240 V AC, 2 A, shall be provided for remote indication of VFD status.

.1 Each relay shall have an adjustable on delay / off delay time.

.4 Two programmable analog inputs shall be provided that can be either direct-or-reverse acting.

.1 Each shall be independently selectable to be used with either an analog voltage or current signal.

.2 The maximum and minimum range of each shall be able to be independently scalable from 0 to 10 V dc and 0 to 20 mA.

.3 A programmable low-pass filter for either or both of the analog inputs must be included to compensate for noise.

.4 The VFD shall provide front panel meter displays programmable to show the value of each analog input signal for system set-up and troubleshooting,

.5 One programmable analog current output (0/4 to 20 mA) shall be provided for indication of VFD status. This output shall be programmable to show the reference or feedback signal supplied to the VFD and for VFD output frequency, current and power. It shall be possible to scale the minimum and maximum values of this output.

.6 It shall be possible through serial bus communications to read the status of all analog and digital inputs of the VFD.

.7 It shall be possible to command all digital and analog output through the serial communication bus.

.8 Optional Control and Monitoring Inputs and Outputs:

.1 It shall be possible to add optional modules to the VFD in the field to expand its analog and digital inputs and outputs.

.2 These modules shall use rigid connectors to plug into the VFD's control card.

.3 The VFD shall automatically recognize the option module after it is powered up. There shall be no need to manually configure the module.

.4 Modules may include such items as:

.1 Additional digital outputs, including relay outputs.

.2 Additional digital inputs.

.3 Additional analog outputs.

.4 Additional analog inputs, including Ni or Pt temperature sensor inputs.

.9 It shall be possible through serial bus communications to control the status of all optional analog and digital outputs of the VFD.

.10 A real-time clock shall be an integral part of the VFD.

.11 It shall be possible to use this to display the current date and time on the VFD's display.

.12 Ten programmable time periods, with individually selectable ON and OFF functions shall be available. The clock shall also be programmable to control start/stop functions, constant speeds, PID parameter setpoints and output relays. Is shall be possible to program unique events that occur only during normal work days, others that occur only on non-work days, and others that occur on specific days or dates. The manufacturer shall provide free PC-based software to set up the calendar for this schedule.

.13 All VFD faults shall be time stamped to aid troubleshooting.

.14 It shall be possible to program maintenance reminders based on date and time, VFD running hours, or VFD operating hours.

.15 The real-time clock shall be able to time and date stamp all faults recorded in the VFD fault log.

.16 The VFD shall be able to store load profile data to assist in analyzing the system demand and energy consumption over time.

.17 The VFD shall include a sequential logic controller to provide advanced control interface capabilities. This shall include:

.1 Comparators for comparing VFD analog values to programmed trigger values.

.2 Logic operators to combine up to three logic expressions using Boolean algebra.

.3 Delay timers.

.4 A 20-step programmable structure.

.18 The VFD shall include a cascade controller which allows the VFD to operate in closed loop set point (PID) control mode one motor at a controlled speed and control the operation of 3 additional constant speed motor starters.

.6 Serial Communications

.1 The VFD shall include a standard EIA-485 communications port and capabilities to be connected to the following serial communication protocols at no additional cost and without a need to install any additional hardware or software in the VFD:

.1 Johnson Controls Metasys N2.

.2 Modbus RTU.

.3 BACnet MS/TP.

.2 VFD shall have standard USB port for direct connection of Personal Computer (PC) to the VFD. The manufacturer shall provide no-charge PC software to allow complete setup and access of the VFD and logs of VFD operation through the USB port. It shall be possible to communicate to the VFD through this USB port without interrupting VFD communications to the building management system.

.3 The VFD shall have provisions for an optional 24 volt DC back-up power interface to power the VFD's control card. This is to allow the VFD to continue to communicate to the building automation system even if power to the VFD is lost.

.7 Adjustments

.1 The VFD shall have a manually adjustable carrier frequency that can be adjusted in 0.5 kHz increments to allow the user to select the desired operating characteristics. The VFD shall also be programmable to automatically reduce its carrier frequency to avoid tripping due to thermal loading.

.2 Four independent setups shall be provided.

.3 Four preset speeds per setup shall be provided for a total of 16.

.4 Each setup shall have two programmable ramp-up and ramp-down times. Acceleration and deceleration ramp times shall be adjustable over the range from 1 to 3,600 seconds.

.5 Each setup shall be programmable for a unique current limit value. If the output current from the VFD reaches this value, any further attempt to increase the current produced by the VFD will cause the VFD to reduce its output frequency to reduce the load on the VFD. If desired, it shall be possible to program a timer, which will cause the VFD to trip off after a programmed time period.

.6 If the VFD trips on one of the following conditions, the VFD shall be programmable for automatic or manual reset: external interlock, under-voltage, over-voltage, current limit, over temperature, and VFD overload.

.7 The number of restart attempts shall be selectable from 0 through 20 or infinitely and the time between attempts shall be adjustable from 0 through 600 seconds.

.8 An automatic “start delay” may be selected from 0 to 120 seconds. During this delay time, the VFD shall be programmable to either apply no voltage to the motor or apply a DC braking current if desired.

.9 Four programmable critical frequency lockout ranges to prevent the VFD from operating the load at a speed that causes vibration in the driven equipment shall be provided. Semi-automatic setting of lockout ranges shall simplify the set-up.

.8 Service Conditions

.1 Ambient temperature, continuous, full speed, full load operation:

.1 -10 to 45°C through 125 HP @ 460 and 600 volt, through 60 HP @ 208 volt

.2 -10 to 40°C 150 HP and larger

.2 0 to 95% relative humidity, non-condensing.

.3 Elevation to 1,000m without derating.

.4 AC line voltage variation, -10 to +10% of nominal with full output.

.5 No side clearance shall be required for cooling.

.6 All power and control wiring shall be done from the bottom.

.7 All VFDs shall be plenum rated.

.9 Quality Assurance

.1 To ensure quality, the complete VFD shall be tested by the manufacturer. The VFD shall drive a motor connected to a dynamometer at full load and speed and shall be cycled during the automated test procedure.

.10 VFD shall utilize a full wave rectifier to convert three-phase AC to a fixed DC voltage. Power factor shall remain above 0.98 regardless of speed or load. VFD’s employing power factor correction capacitors shall not be acceptable.

.11 An internal line reactor (5% impedance) shall be provided to lower harmonic distortion of the power line and to increase the fundamental power factor.

.12 The VFD shall be suitable for elevations to 1,000m above sea level without de-rating. Maximum operating ambient temperature rating shall not be greater than 40°C. VFD shall be suitable for operation in environments up to 95% non-condensing humidity.

.13 The VFD shall be capable of displaying the following information in plain English via an alphanumeric display:

.1 Output Frequency

.2 Output Voltage

.3 Motor Current

.4 Kilowatts per hour

.5 Fault identification with text

.6 Percent torque

.7 Percent power

.8 RPM

.14 The VFD shall have the ability to automatically restart after an over-current, overvoltage, under-voltage, or loss of input signal protective trip. The number of

restart attempts, trial time, and time between reset attempts shall be programmable.

.15 Three (3) programmable critical frequency lockout ranges to prevent the VFD from operating the load continuously at an unstable speed.

.16 Operator Control Panel (Keypad)

.1 Each VFD shall be equipped with a front mounted operator control panel (keypad) consisting of a backlit, alphanumeric, graphic display and a keypad with keys for Start/Stop, Local/Remote, Up/Down and Help. Two (2) Soft-keys will be provided which change functionality depending upon the position within the parameter hierarchy or state of panel.

.2 All parameter names, fault messages, warnings and other information shall be displayed in complete English words or Standard English abbreviations to allow the user to understand what is being displayed without the use of a manual or cross-reference table.

.3 The Display shall have contrast adjustment provisions to optimize viewing at any angle.

.4 The control panel shall provide a real time clock for time stamping events and fault conditions.

.5 The control panel shall include a feature for uploading parameter settings to control panel memory and downloading from the control panel to the same Drive or to another Drive.

.6 All Drives throughout the entire power range shall have the same customer interface, including digital display, and keypad, regardless of horsepower rating.

.7 The keypad shall be able to be installed or removed from the drive while it is powered, capable of remote mounting, and shall have its own non-volatile memory.

.17 Protective Functions:

.1 For each programmed warning and fault protection function, the Drive shall display a message in complete English words or Standard English abbreviations. The three (3) most recent fault messages along with time, current, speed, voltage, frequency and DI Status shall be stored in the Drive's fault history. The last ten (10) fault names shall be stored in Drive memory.

.2 The Drive shall include internal MOV's for phase to phase and phase to ground line voltage transient protection.

.3 Output short circuit withstand rating and ground fault protection rated for 100,000 AIC shall be provided per UL508C without relying on line fuses. Motor phase loss protection shall be provided.

.4 The Drive shall provide electronic motor overload protection qualified per UL508C.

.5 Protection shall be provided for AC line or DC bus overvoltage at 130% of maximum rated or under voltage at 65% of min. rated and input phase loss.

.6 A power loss ride through feature will allow the Drive to remain fully operational after losing power as long as kinetic energy can be recovered from the rotating mass of the motor and load.

.18 Integrated Drive Disconnects

.1 3-Phase: Individual integrated drive fused disconnects shall have exterior operators.

.2 Single-Phase: Individual integrated drive disconnects shall have exterior operators and external fusing.

.19 Variable Speed System Sequence of Operation

.1 The system shall consist of a pump logic controller with multi-pump parallel operation control, duty-standby pump selection, automatic alternation and automatic transfer to the standby pump upon pump/VFD failure.

.2 The pumping system shall start upon the closure of customer's contact when the pump logic controller Mode of Operation is in REMOTE.

.3 When the pump logic controller mode in LOCAL, the pumping system shall operate automatically. d. Each sensor/transmitter shall send a 4-20mA signal to the pump logic controller, indicative of process variable condition.

.4 When the set point is satisfied by the process variable, the pump speed shall remain constant at the optimum energy consumption level.

.5 When the process variable exceeds the allowable drift from the set point for a set time the pump controller shall automatically start the next lag pump and continue in this fashion as necessary to satisfy system demand. To maintain system set point the controller will operate the pumps synchronously or sequentially to ensure maximum energy conservation.

.6

.7 As demand is satisfied, the controller shall automatically stop lag pumps as necessary to conserve energy.

.8 In the event of a pump failure or a VFD fault, the pump logic controller automatically initiates a timed sequence of operation to start the redundant pump/VFD set in the variable speed mode.

.9 In the event of the failure of a zone sensor/transmitter, its process variable signal shall be removed from the scan/compare program. The redundant zone sensor/transmitters, if available, shall remain in the scan/compare program for control.

.10 PUMP or VFD hard fault shall be flash continuously on the display on the operator interface of the pump logic controller until the fault has been corrected and the controller has been manually reset.

.11 When the system is satisfied, the pump controller shall shut down the single running lead pump without the need of a flow sensor/switch or hydro-pneumatic tank and enter energy saving / no flow shutdown mode.

.3 MECHANICAL

.1 Pump Station Frame and Piping

.1 Framing shall be designed and fabricated to provide structural support for all attached equipment, and provide anchor bolt support. The base shall supply sufficient rigidity to withstand the stresses of reasonable and competent transportation to site, off loading, installation, and operation.

.2 Piping shall be constructed from 304 stainless steel, schedule 10 or heavier pipe as required to maintain a 3 to 1 pressure safety factor (including 1/16” corrosion allowance).

.2 Stainless steel vertical multi-stage Pumps:

.1 Compliant to ANSI/NSF-61 Annex G

.2 AISI 304 wetted components

.3 Impeller: AISI 304

.4 Diffuser: AISI 304

.5 Shaft: AISI 316 (sizes 1 – 22SV) • Duplex ASTM-A182 (sizes 33-92SV)

.6 External sleeve: AISI 304

.7 Pump body: AISI 304

.8 Seal housing: AISI 304

.9 Mechanical seal: all material options NSF/ANSI-61 compliant

.3 Isolation Ball Valves

.1 Isolation ball valves shall be certified to NSF-61 for use with potable drinking water.

.2 Isolation ball valves shall be certified as low lead having wetted surface area with a weighted average lead content<0.25%.

.3 Valves shall be rated for 600 psi WOG / 150 psi WSP for valves ¼" to 2" and 400 psi WOG / 125 psi WSP for valves 2-1/2" to 4".

.4 Seats and stem packing shall be virgin PTFE. Stem shall be bottom loaded blowout proof design with fluorocarbon elastomer O-ring to prevent stem leaks.

.5 Valves shall be 2-piece full port design.

.4 Isolation Grooved Butterfly Valves

.1 Valves shall be certified to NSF-61 for use with potable drinking water.

.2 Valve bodies shall be nylon coated ductile iron conforming to ASTM A536 with integral neck and ISO mounting top.

.3 The disc shall be encapsulated with Gr. E EPDM for cold and hot water services.

.4 Valves shall be rated for 300 psi CWP

.5 Isolation Lug Style Butterfly Valve

.1 Valve shall be certified to NSF-61 for use with potable drinking water.

.2 Valve body shall be made of ASTM 536 ductile iron and will be coated with an FDA approved epoxy. Valve face to face dimensions shall comply with API 609 and MSS-SP-67.

.3 Disc shall be made of ASTM A-351 stainless steel. Shaft shall be made of 316SS.

.4 Bushing shall be made of a Teflon®-Darcon inner liner bonded to fiberglass-epoxy resin outer shell.

.5 Seat shall be EPDM.

.6 Valve shall be rated to 200 psi WOG.

.6 Threaded Check Valves

.1 All valve metallic components shall be 316SS.

.2 Seat shall be Viton.

.3 Valve shall be rated for 400 psi WOG.

.7 Wafer Check Valves

.1 The valve body shall be constructed of ASTM A126 Class B cast iron for Class 125/150 and Class 250/300 valves.

.2 The seat and disc shall be ASTM B584 Alloy C83600 cast bronze or ASTM B148 Alloy C95200 aluminum bronze.

.3 The compression spring shall be ASTM A313 Type 316 Stainless Steel with ground ends.

.4 Valve interiors and exteriors shall be coated with an NSF/ANSI-61 certified fusion bonded epoxy in accordance with AWWA C550.

.5 The exterior of the valve shall be coated with a universal alkyd primer.

.6 The valve design shall incorporate a center guided, spring loaded disc, guided at opposite ends and having a short linear stroke that generates a flow area equal to the nominal valve size.

.7 The operation of the valve shall not be affected by the position of installation. The valve shall be capable of operating in the horizontal or vertical positions with the flow up or down.

.8 All component parts shall be field replaceable without the need of special tools. A replaceable guide bushing shall be provided and held in position by the spring. The spring shall be designed to withstand 100,000 cycles without failure and provide a cracking pressure of 0.5 psi.

.9 The valve disc shall be concave to the flow direction providing for disc stabilization, maximum strength, and a minimum flow velocity to open the valve.

.10 The valve disc and seat shall have a seating surface finish of 16 micro-inch or better to ensure positive seating at all pressures. The leakage rate shall not exceed the allowable rate for metal-seated valves allowed by AWWA Standard C508 or 1 oz (30 ml) per hour per inch (mm) of valve diameter.

.11 The valve flow way shall be contoured and unrestricted to provide full flow areas at all locations within the valve. Cv flow coefficients shall be equal to or greater than specified below and verified by an independent testing laboratory.

VALVE SIZE – MM	**WAFER STYLE - Cv**
50	43
65	88
80	130
100	228
125	350
150	520

.12 The valves shall be hydrostatically tested at 1.5 times their rated cold working pressure and seat tested at the valve CWP.

.8 Sensor / Transmitters:

.1 Pressure transducer shall be utilized for providing all pressure signals for the pump control logic. Pressure transducer shall be a solid-state bonded strain gage-type with an accuracy of < ±0.5% BFSL and constructed of 316 stainless steel. Transducer shall be rated for a pressure of 2,068 kPa and shall provide gauge pressure output, rather than an absolute. Pressure

transducer constructed of plastic is not acceptable. Pressure transducer shall be 4-20mA analog type with 10-28 VDC supply range, shall utilize a Packard-type connector to prevent moisture intrusion, and include surge protection to protect against voltage spikes.

.9 Flowmeter:

.1 Provide a field mounted flow sensor transmitter as indicated on the plans. Unit shall transmit an isolated 4-20 mA dc signal indicative of process variable to the pump logic controller via standard two wire 24 VDC system. Unit shall consist of an insertion probe and separately mounted transmitter. The unit shall be accurate to within 1% of flow rate from 0.305 to 9.15 mps and shall withstand a static pressure of 1,379 kPa with negligible change in output.

.10 Pressure Gauges:

.1 Gauges shall be provided for the suction and discharge manifold.

.2 Accuracy shall be ±1.5%

.3 Bourdon tube and connection shall be constructed of 316SS.

.4 Case, bezel and internals shall be constructed of 316SS.

.5 Gauge shall be filled with glycerin in order to dampen pulsation and vibration and to provide lubrication to the internal parts.

.6 Gauge range shall be selected to cover the largest operating range for the specific conditions and pump selected.

.11 Flange Bolts

.1 Bolts shall be zinc plated and shall meet ASTM Grade A193 B7.

.12 Paint

.1 Standard finish coat shall be acrylic enamel to a thickness of no less than 3 mils.

Part 3 EXECUTION

3.1 INSTALLATION

.1 Install equipment in accordance with manufacturer's instructions.

The contractor shall align the pump and motor shafts to within the manufacturer's recommended tolerances prior to system start-up.

Power wiring, as required, shall be the responsibility of the electrical contractor. All wiring shall be performed per manufacturer’s instructions and applicable state, federal and local codes.

Control wiring for remote mounted switches and sensor / transmitters shall be the responsibility of the controls contractor. All wiring shall be performed per manufacturer’s instructions and applicable state, federal and local codes.

3.2 DEMONSTRATION/TRAINING

.1 The system manufacturer’s factory qualified representative shall be capable of providing optional start-up of the packaged pumping system. This start-up shall include verification of proper installation, system initiation, adjustment, and fine

tuning. Start-up shall not be considered complete until the sequence of operation, including all alarms, has been sufficiently demonstrated to the owner or owner's designated representative. This job site visit shall occur only after all hook-ups, tie-ins, and terminations have been completed and signed-off on the manufacturer's start-up request form.

The system manufacturer's factory qualified representative shall be capable of providing on-site training for owner's personnel. This training shall fully cover maintenance and operation of all system components.

The system manufacturer must have an optional complete pressure booster system training program available for owner's personnel. The training sessions shall take place at the manufacturer's facility and cover all aspects of pressure booster system design, service and operation.

3.3 WARRANTY

The manufacturer shall warrant the water pumping system to be free of defects in material and workmanship for eighteen (18) months from date of authorized Start-up. A written warranty statement shall be provided with the submittals.

The complete VFD shall be warranted by the manufacturer for a period of thirty (30) months from date of shipment. The warranty shall include parts, labor, travel costs and living expenses incurred by the manufacturer to provide factory authorized on-site service. The warranty shall be provided by the VFD manufacturer and not a third party.

A written warranty statement shall be provided with the submittals.

3.4 START-UP SERVICE

.1 Owner start up assistance will be provided by a manufacturer-qualified representative and will be limited to one (1) eight-hour (8) day for all VFDs, unless previously negotiated by the factory representative.

When discharge piping, electrical connections, and electrical inspection have been completed, the pump station representative shall be contacted for start up.

A minimum two-week notice shall be given to the manufacturer-qualified representative prior to scheduled start up date.

During start up, the complete pumping system shall be given a running test of normal start and stop, and fully loaded operating conditions. During this test, each pump shall demonstrate its ability to operate without undue vibration, or overheating, and shall demonstrate its general fitness for service.

All defects shall be corrected and adjustments shall be made to the pumping station for satisfactory operation. System problems or concerns will be corrected by the general contractor or site station staff, in conjunction with the appropriate factory qualified representative.

Testing shall be repeated until satisfactory results are obtained, as determined by the Departmental Representative.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 The installation of drainage waste and vent piping.

1.2 REFERENCES

.1 American Society for Testing and Materials International, (ASTM).

.1 ASTM C564-03a, Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.

.2 Canadian Standards Association (CSA International).

.1 CSA B67-1972(R1996), Lead Service Pipe, Waste Pipe, Traps, Bends and Accessories.

.2 CAN/CSA-B70-02, Cast Iron Soil Pipe, Fittings and Means of Joining.

.3 CAN/CSA-B125-01, Plumbing Fittings.

1.3 CAST IRON PIPING AND FITTINGS

.1 Buried sanitary and vent minimum NPS 3 , to: CAN/CSA-B70, with one layer of protective coating of .

.1 Joints.

.1 Mechanical joints.

.1 Neoprene or butyl rubber compression gaskets: to ASTM C564 or CAN/CSA-B70.

.2 Stainless steel clamps.

.2 Hub and spigot.

.1 Caulking lead: to CSA B67.

.2 Cold caulking compounds.

.2 Above ground sanitary storm and vent : to CAN/CSA-B70.

.1 Joints.

.1 Hub and spigot.

.1 Caulking lead: to CSA B67.

.2 Mechanical joints.

.1 Neoprene or butyl rubber compression gaskets with stainless steel clamps.

Part 2 Execution

2.1 INSTALLATION

.1 In accordance with Section 23 05 05 - Installation of Pipework.

.2 Install in accordance with Canadian Plumbing Code and local authority having jurisdiction.

2.2 TESTING

.1 Pressure test buried systems before backfilling.

.2 Hydraulically test to verify grades and freedom from obstructions.

2.3 PERFORMANCE VERIFICATION

.1 Cleanouts:

.1 Ensure accessible and that access doors are correctly located.

.2 Open, cover with linseed oil and re-seal.

.3 Verify that cleanout rods can probe as far as the next cleanout, at least.

.2 Test to ensure traps are fully and permanently primed.

.3 Storm water drainage:

.1 Verify domes are secure.

.2 Ensure weirs are correctly sized and installed correctly.

.3 Verify provisions for movement of roof system.

.4 Ensure that fixtures are properly anchored, connected to system and effectively vented.

.5 Affix applicable label, sanitary, vent, pump discharge etc.) c/w directional arrows every floor or 4.5 m (whichever is less).

2.4 VERIFICATION

.1 Not used.

END OF SECTION